MONTHLY PROGRESS REPORT
SLURRY/MICRO-SURFACE MIX DESIGN PROCEDURE
APRIL 2004

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Contract No.: **CALTRANS 65A0151**
Contractor: **Fugro Consultants LP**
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PROJECT OVERVIEW

The overall goal of this research is to improve the performance of slurry seal and micro-surfacing systems through the development of a rational mix design procedure, guidelines, and specifications.

Phase I of the project has two major components: 1) the first consists of a literature review and a survey of industry/agencies using slurry and micro-surfacing systems, 2) the second part of Phase I deals with the development of a detailed work plan for Phases II and III.

In Phase II, the project team will evaluate existing and potential new test methods, evaluate successful constructability indicators, conduct ruggedness tests on recommended equipment and procedures, and prepare a report that summarizes all the activities undertaken under the task.

In Phase III, the project team will develop guidelines and specifications, a training program, and provide expertise and oversight in the construction of pilot projects intended to validate the recommended design procedures and guidelines. All activities of the study will be documented in a Final Report.

PHASE I—LITERATURE SEARCH AND WORK PLAN DEVELOPMENT

Task 1—Literature Review and Industry Survey

Task 1.1 Literature Review

Completed
The literature review process is completed with all sources of information on the design and use of micro-surfacing and slurry seals reviewed and summarized in Chapter 2 of the Phase I Report. Following is a representative list of references:

ISSA Recommended Performance Guidelines for Slurry Seal Mix Design (A105) and Micro-Surfacing (A143)

- ASTM D3910-98 and ASTM D6372-99 Practice for Design, Testing and Construction of Slurry Seal and Micro-Surfacing respectively
- TTI Reports 0-1289-1 & 1289 2-F
- ISSA Design Technical Bulletins
- ISSA Conference Proceedings
- European Standards EN 12274-1 to 12274-8 Slurry Surfacing Test Methods Part 1 to Part 8.
- Technical Guideline: The use of Modified Bituminous Binders in Road Construction. Asphalt Academy c/o Transportek, CSIR
- Austroads – Guide to the Selection and Use of Bitumen Emulsions
- Micro-Surfacing Pilot Study 2001, Caltrans
- Ministry of Transportation, Ontario: Micro Performance Study
- Friction Evaluation of Slurry Systems in Kansas
- Pennsylvania Department of Transportation Research Report No. 89-61
- FHWA Long Term Pavement Performance (LTPP) SPS-3
- Road Trials of Stone Mastic Asphalt and Other Thin Surfacings, England
- MnROAD 1999 State Micro Surfacing Project
- City of Saskatoon, Saskatchewan, Micro-Surfacing Program

Planned
Although the literature review process is finalized, any new information will be reviewed as it becomes available.

Task 1.2 Industry, Agency, and Advisory Panel Surveys

Completed
Following discussion with members of the team and Caltrans, three surveys were designed:

- Agencies: Those using the AASHTO LISTSERVE link (United States and Canada).

- Contractors and Manufacturers: Those in the United States and the international slurry surfacing and micro-surfacing industry.

- Advisory Panel Contractors.

The three proposed survey questionnaires were included in the August 2003 monthly report and discussed at the videoconference kickoff meeting on September 22, 2003. Based on the comments and suggestions of the participants at the videoconference, the questionnaires were revised and included in final form in the September 2003 monthly report.

The results of the surveys were summarized in the Phase I Report.

Major Conclusions
The major conclusions of the literature search are provided here:

- All the mix design methods currently used by practitioners closely follow the ISSA Guidelines A105 and A143. Minor modifications consist of addition or deletion of certain laboratory tests, according to local agency requirements.

- The design methods for slurry seals and micro-surfacing are very similar; additional tests or test results reflecting higher performance are specified for micro-surfacing.

- The "guideline" character of these methods has a two fold implication: on one hand, it allows the designer to adapt the design to specific project conditions, materials and local agency requirements; on the other hand, designers that do not have extensive experience with similar projects and materials may have difficulties in selecting an optimum design out of a rather wide window of possible designs.

- All methods investigated are rather vague in describing the minimum number of replicate tests, the number of test specimens, and the range of conditions to be used with a specific test (e.g., range of variation in temperature, humidity, soaking time). It would be helpful to provide these details for every laboratory test used as part of the design procedure.

- The repeatability of all recommended laboratory tests should be investigated.

- The great majority of the existing slurry seal and micro-surfacing field projects contain information on the short-term performance of these systems, but very limited or no long-term performance data.

- Project selection and the experience of the construction crew are of crucial importance to the success of micro-surfacing and slurry seal projects.

Task 2—Work Plans for Phases II and III

Completed

The first draft of the Phase II Work Plan has been finalized and is included in Chapter 3 of the Phase I Report. In summary, five mixes will be included in the laboratory testing factorial. The new approach is to measure the mechanical properties of the mixtures throughout the process. This is broken into construction issues and performance issues (short term and long term).

A test developed in Germany is being proposed as the method by which the mixing characteristics are measured. This will measure a profile of cohesion change during mixing allowing a mixability index and a spreadability index to be defined and specified. The apparatus consists of a special impeller mixer that is attached to a strain measurement device and a computer.

It is proposed that the short-term cohesion build be measured by an automated ISSA TB139 wet cohesion test. This will allow a traffic cohesion and early strength cohesion to be defined and specified. Both tests may be done under a range of test conditions. The apparatus is being developed.

Another cohesion type measurement is the French WTAT that uses a wheel assembly instead of a rubber hose. This test is also being developed for long term testing of abrasion resistance of cured materials.

The draft of the Phase III Work Plan has been finalized and is included in Chapter 4 of the Phase I Report.

On February 24, 2004, members of the research team met in San Diego with CALTRANS and members of the panel to discuss the results of the Phase I effort. The team presented the conclusions and findings of the literature search and surveys followed by presentations of the work plans for Phases II and III. The panel made recommendations on the Phase I Report and the Phase II and III work plans.

The team submitted the final copy of the Phase I Report to CALTRANS early in March 2004.

PHASE II—MIX DESIGN PROCEDURE DEVELOPMENT

This Month:
Members of team met in Sacramento on April 15-16, for a kick-off meeting for Phases II and III. Although according to the project schedule we are at the beginning of Phase II the team was authorized to proceed with work in both Phase II and Phase III where possible. Several things were discussed:

Response to Panel Comments
The team addressed the comments of the panel in a letter sent to Caltrans shortly after the April 15-16 meeting. The main subjects discussed were:

- Binder testing and characterization
- Training program and materials
- Field acceptance test for slurry systems

The Difference between Slurry Seal and Micro-Surfacing
This question was raised by members of the team as well as members of the panel and other professionals outside the team. The distinction between slurry seal and micro-surfacing was primarily made for marketing purposes. At the time micro-surfacing was marketed as a new and better product, the main differences generally found between the two products were the ones outlined in below:

Parameter	Slurry Seal	Micro-Surfacing
Aggregate Quality	Standard Quality	Better Quality
Binder	Standard Emulsion	Polymer Modified Emulsion
Traffic time	24 hours	1 hour
Rut resistant (stackable) ?	No	Yes

However, the names micro-surfacing and slurry seal are not necessarily relevant to either the component materials or the performance of the mix in the field and the differences noted above are no longer valid. Polymer modified slurry seals may perform similar or better than certain “micro-surfacing” products. Mixtures made of the exact same materials but in different

proportions will perform differently in the field. For purposes of clarification and to avoid any confusion, a common nomenclature is recommended by the team: ***slurry systems***. A more rational way to differentiate between slurry systems will be based on the results of the laboratory tests recommended in Phase II. Therefore, the term ***slurry systems*** will be used in the future to refer to all products traditionally referred to as "slurry seal" or "micro-surfacing."

Phases II and III Work Plan Discussion
Several aspects of the Phase II and Phase III efforts were discussed and are presented under the corresponding tasks of this progress report:

Tasks 3 & 4—Evaluation of Potential Test Methods & Successful Constructability Indicators

This Month:
The team is working towards the acquisition of the new test equipment to be used in Phase II. None of the equipment is currently available but arrangements are being made to buy new parts or modify existing equipment. The equipment includes:

- Visco-Time®: an apparatus that will measure the rotational viscosity of a slurry system with time. The results will be used to evaluate the time available for mixing and spreading the mixture in the field and an estimate of the set time.
- French wet track device (FWTAT): an apparatus that is very similar to the Wet Track Abrasion Test (WTAT) but uses a set of wheels instead of the rubber hose normally used for the abrasion head.
- Modified cohesion tester: basically an automated modified cohesion tester, i.e. the torque will not be applied manually but by means of an automated device.
- Environmental Chamber: many of the tests of Phase II will be performed under controlled temperature and humidity conditions that require the use of one or several environmental chambers.

The matrix of tests to be performed in Task 3 is being reviewed by the team; a range of conditions will be used in the test program:

- Humidity: high and low
- Temperature: 10, 25 and 30°C (50, 77 and 86°F)
- Cure time: 30, 60, 90 minutes; 12 and 24 hours
- Soak time: 1hour; 1,3,6 and 9 days

Tentatively, 5 mixes will be included in the test program of which 4 are made of aggregates and binders known to perform well in slurry systems and 1 will be made of materials for which the performance is not known.

Task 5—Ruggedness Tests of Recommended Equipment and Procedures

This Month:
In comparison with the testing in Tasks 3 and 4, the tests of Task 5 will be performed at a single set of temperature, humidity, and cure time conditions. "Standard" conditions were chosen by

the team: 50% humidity, 25°C temperature, etc. Slight variations in these parameters will be allowed to evaluate the ruggedness of the test procedures. The team is currently reviewing the test factorials proposed in the Phase II Work Plan.

Task 6—Phase II Report
No Activity

PHASE III— PILOT PROJECTS AND IMPLEMENTATION

Task 7—Development of Guidelines and Specifications

This Month:
A list of references that contain guidelines and specifications has been drafted and is noted below:

- ISSA A105 Guidelines for Slurry Seal - Available
- ISSA A143 Guidelines for Micro-Surfacing - Available
- TTI Report 1289-2F Use of Micro-Surfacing in Highway Pavements (contains Methods and Materials Specifications, Quality Control and Assurance (Tests - including field cohesion test and vane shear test, Guidelines – including materials acceptance tests and mixture design verification, and a Checklist), and Usage Guidelines – Available
- ISSA Inspector's Manual – Not Available
- Caltrans Maintenance Technical Advisory Guide Final Draft – Available
- The ISSA Workshop Folder - Available

The guidelines and specifications will be a concise collection of guidelines and specifications in AASHTO format. This is one area of the Phase III where the team can be working. At the end of Phase II, the document will be appended with findings and recommendations relative to the new tests developed in Phase II.

Task 8—Workshop Training Program/Pre-Construction Module

This Month:
The team agreed that work could commence in several chapters of the reference manual to be developed under this task. The reference manual will be a comprehensive, textbook-like document with background information, explanations and pertinent information on the design and use of slurry systems.

Task 9—Pilot Projects/Procedure Validation

This Month:
The team is working on the development of guidelines for selecting pilot projects to be used by state agencies. Currently, the proposed pilot project layout contains six different sections:

- A control section placed using the ISSA current procedure.

- A bare section (do nothing)
- Improved mix design (using the method developed in Phase II), Replicate 1
- Improved mix design (using the method developed in Phase II), Replicate 2
- Another bare section.
- Another contractor-based control (ISSA design).

Task 10—Final Report
No Activity

NEXT MONTH'S WORK PLAN

The activities planned for next month are listed below.

- Coordinate with CALTRANS personnel on an as-needed basis.
- Proceed with Phase II and Phase III activities.

PROBLEMS / RECOMMENDED SOLUTIONS

No problems were encountered during last month and none are anticipated next month.
